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Mass Spectrometry of Art and Cultural Heritage

Ester S.B. Ferreira, Ron M.A. Heeren, Klaas Jan van den Berg, Christopher Maines, Ken Sutherland, Catherine Higgitt

Regular articles

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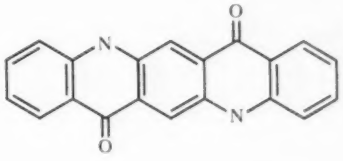
The use of direct temperature-resolved mass spectrometry (DTMS) in the detection of organic pigments found in acrylic paints used by Sam Francis

Carrie Ann Menke, Rachel Rivenc, Tom Learner

A project aiming to characterize the wide range of pigments found in the paints of Sam Francis (American, 1923–1994) prompted work to investigate more fully the sensitivity of a DTMS system by comparing various ionization conditions, including electron impact (EI) at 70 and 16 eV, and chemical ionization (CI) with iso-butane in both positive- and negative-ion modes.

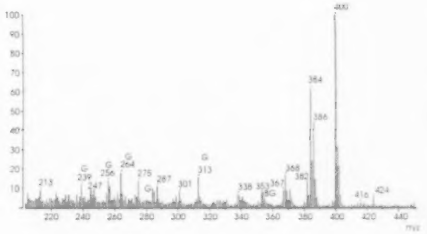


12–21

A direct temperature-resolved tandem mass spectrometry study of cholesterol oxidation products in light-aged egg tempera paints with examples from works of art

Oscar F. van den Brink, Ester S.B. Ferreira, Jerre van der Horst, Jaap J. Boon

The fate of cholesterol upon light ageing of egg tempera paint binding medium was investigated by direct temperature resolved mass spectrometry (DTMS) and tandem mass spectrometry (DTMSMS).



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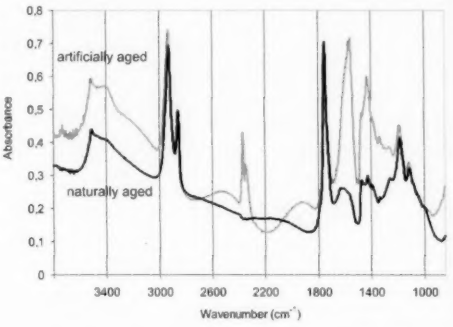
22–34

Evaluation of the "added value" of SIMS: A mass spectrometric and spectroscopic study of an unusual Naples yellow oil paint reconstruction

Katrien Keune, Frank Hoogland, Jaap J. Boon, David Peggie, Catherine Higgitt

Naples yellow-containing oil paints aged under natural and artificial conditions were investigated as model systems to evaluate the potential of secondary ion mass spectrometry (SIMS) when used in combination with other mass spectrometric and spectroscopic analytical methods.

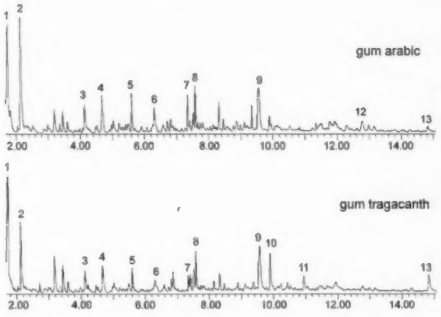


35–41

Gas chromatography–mass spectrometric analysis of products from on-line pyrolysis/silylation of plant gums used as binding media

Oscar Chiantore, Chiara Riedo, Dominique Scalarone

This paper describes a method where two plant gums, arabic and tragacanth, were pyrolized in presence of silylating agents (HMDS e BSTFA alone and with TMCS as catalyst) using an on-line Py-GC/MS apparatus.

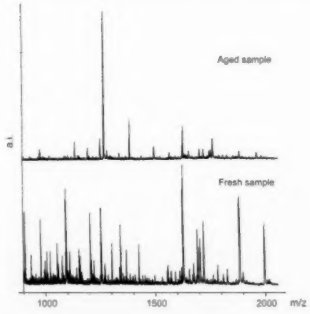


42–46

Towards proteomic analysis of milk proteins in historical building materials

S. Kuckova, M. Crhova, L. Vankova, A. Hnizda, R. Hynek, M. Kodicek

The addition of proteinaceous binders to mortars and plasters has a long tradition. The protein additions were identified in many sacral and secular historical buildings. For this method of peptide mass mapping, three model mortar samples with protein additives were prepared.



47–56

Analysis of archaeological triacylglycerols by high resolution nanoESI, FT-ICR MS and IRMPD MS/MS: Application to 5th century BC–4th century AD oil lamps from Olbia (Ukraine)

Nicolas Garnier, Christian Rolando, Jakob Munk Høtje, Caroline Tokarski

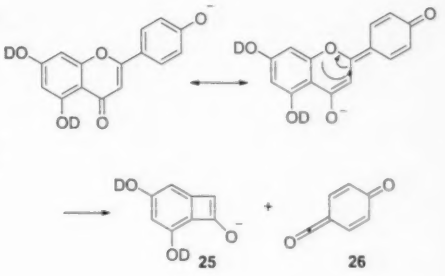
Triacylglycerol (TAG) extracts from of archaeological oil lamps were analyzed by lithium cationisation nanoESI, IRMPD, FT-MS identifying that bovine/ovine fats were used as fuel.

57–65

Negative ion ESI–MS analysis of natural yellow dye flavonoids—An isotopic labelling study

Hamish McNab, Ester S.B. Ferreira, Alison N. Hulme, Anita Quye

In this paper, evidence from isotopically labelled substrates is used to propose negative ion electrospray collision induced decomposition mechanisms of flavones, flavonols and an isoflavone.

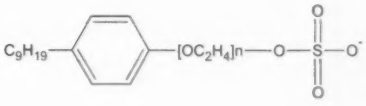


66–71

Development of MALDI-MS and nano-ESI-MS methodology for the full identification of poly(ethylene glycol) additives in artists' acrylic paints

F.G. Hoogland, J.J. Boon

An analytical mass spectrometric method was developed for the comprehensive characterization of the poly(ethylene glycol) based additives present in water extracts of acrylic emulsions, acrylic emulsion paints and samples from paintings.

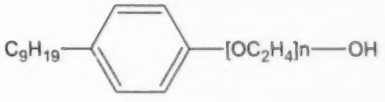


72–80

Analytical mass spectrometry of poly(ethylene glycol) additives in artists' acrylic emulsion media, artists' paints, and microsamples from acrylic paintings using MALDI–MS and nanospray-ESI–MS

F.G. Hoogland, J.J. Boon

Poly(ethylene glycol) compounds in artists' acrylic emulsion paint products from different paint manufacturers were characterised with a newly developed mass spectrometric method which combines data from MALDI–MS and nano-ESI–MS(MS).



81–92

Ageing behaviour and analytical characterization of the *Jatobá* resin collected from *Hymenaea stigonocarpa* Mart.

María Teresa Doménech-Carbó, Juana de la Cruz-Cañizares, Laura Osete-Cortina, Antonio Doménech-Carbó, Helena David

This paper reports the results of an analytical study to characterize the trunk resin collected from the *Hymenaea stigonocarpa* Mart. species from the region of Minas Gerais (Brazil), popularly known as *Jatobá* resin.

93–97

Determination of the type of lacquer on East Asian lacquer ware

Noriyasu Niimura

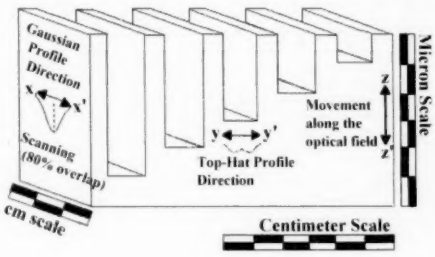
The type of lacquer on East Asian lacquer ware was determined by using direct inlet mass spectrometry and pyrolysis-gas chromatography/mass spectrometry.

98–107

Direct temperature mass spectrometric study on the depth-dependent compositional gradients of aged triterpenoid varnishes

Charis Theodorakopoulos, Jaap J. Boon, Vassilis Zafiropulos

The depth profiles of aged dammar and mastic films, which were uncovered by optimized KrF excimer laser ablation (248 nm, 25 ns), were examined by direct temperature-resolved mass spectrometry (DTMS).

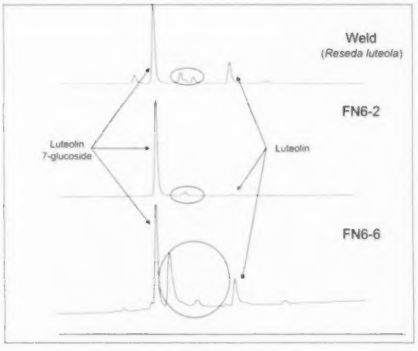


108–114

Application of LC–MS to the analysis of dyes in objects of historical interest

Xian Zhang, Richard Laursen

High-performance liquid chromatography (HPLC) with photodiode array and mass spectrometric detection permits dyes extracted from objects of historical interest or from natural plant or animal dyestuffs to be characterized on the basis of three orthogonal properties: HPLC retention time, UV–visible spectrum and molecular mass.

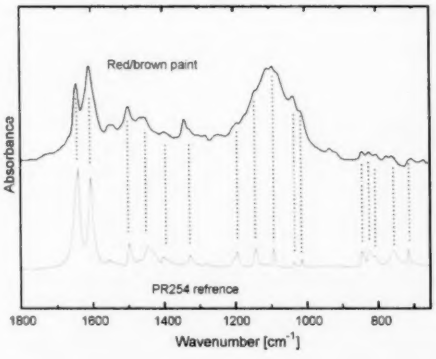


115–122

Applications of laser desorption mass spectrometry for the study of synthetic organic pigments in works of art

Daniel P. Kirby, Narayan Khandekar, Ken Sutherland, Beth A. Price

This paper describes the application of laser desorption mass spectrometry (LDMS) to the identification of synthetic organic pigments in microscopic samples from works of art.



123–130

A diagnosis of the yellowing of the marble high reliefs and the black decorations in the chapel of the tomb of Saint Anthony (Padua, Italy)

Alessia Andreotti, Ilaria Bonaduce, Maria Perla Colombini, Francesca Modugno, Erika Ribechini

This paper focuses on the chemical characterization of samples of black decorations and inscriptions, and of yellow-brown patinas collected from various panels of the ark from the chapel of Saint Anthony (Padua, Italy), using three analytical procedures based on gas chromatography/mass spectrometry (GC/MS).

131–141

Identification of resinous materials on 16th and 17th century reverse-glass objects by gas chromatography/mass spectrometry

Ursula Baumer, Patrick Dietemann, Johann Koller

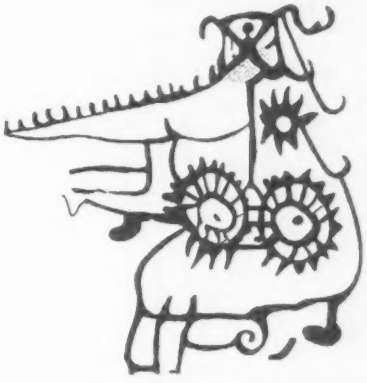
The binding media of two precious objects of *hinterglasmalerei* from the 16th and 17th century have been identified as almost exclusively resinous. Identification was performed by a special optimised analysis procedure, which is discussed in this paper: solvent extracts are analysed by gas chromatography/mass spectrometry, both with and without derivatisation or hydrolysis.

142–151

Characterizing the binders in rock paintings by THM-GC–MS: La Casa de Las Golondrinas, Guatemala, a cautionary tale for radiocarbon dating

Andrew Livingston, Eugenia Robinson, Ruth Ann Armitage

Using plasma-chemical oxidation and accelerator mass spectrometry, radiocarbon dates (6250–5550 cal B.C. and 1500–900 cal B.C.) were obtained for two redpigmented pictographs from La Casa de Las Golondrinas, the largest recorded rock art site in the Guatemalan Highlands.

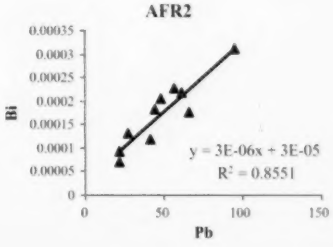


152–161

LA-ICP-MS analysis of African glass beads: Laboratory inter-comparison with an emphasis on the impact of corrosion on data interpretation

Laure Dussubieux, Peter Robertshaw, Micheal D. Glascock

A comparison between the compositions determined by laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) from two different laboratories on 52 ancient beads recovered in Africa was undertaken.



162–169

Gas chromatography/mass spectrometry methods applied for the analysis of a Round Robin sample containing materials present in samples of works of art

Henk van Keulen

An artificial, complex Round Robin sample was sent to fifteen laboratories specializing in the analysis of cultural materials. The results of the confirming GC/MS analysis of the sample by the author are presented and compared with the results of the participants. The results show that thermally assisted hydrolysis and methylation GC/MS in combination with pyrolysis is a powerful technique for the analysis of multi-component samples. The presence of gums and proteins can be indicated. Synthetic resins such as acrylics can also be analyzed in combination with the traditional binders and resins.

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